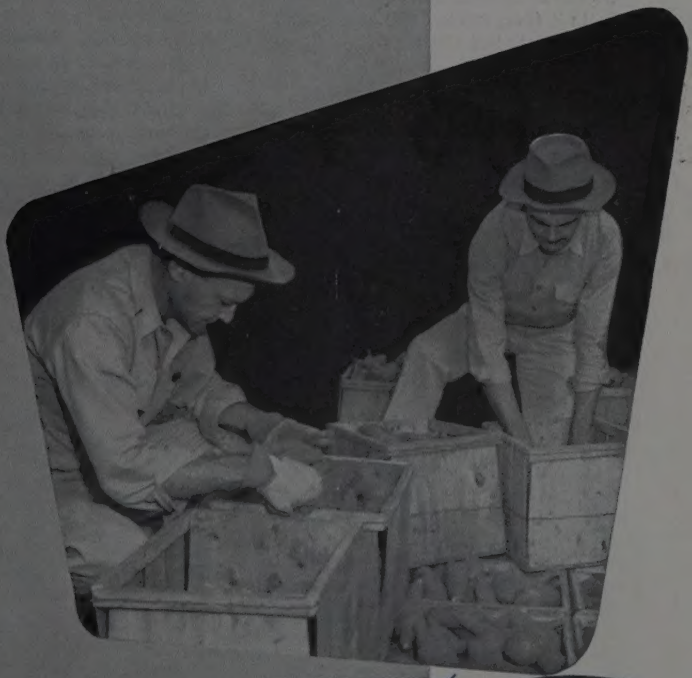
SWEETPOTATO

Diseases



NSP
RAM
MM

COMMONWEALTH MYCOLOGICAL
27 AUG 1963

Farmers' Bulletin No. 1059

U. S. DEPARTMENT OF AGRICULTURE

Contents

	Page
Field diseases and their control	3
Stem rot (wilt, blue stem, yellow blight)	3
Black rot (black shank, black root)	6
Foot rot (die off)	8
Scurf (soil stain, rust, Jersey mark)	9
Root rot (Texas root rot)	10
Mottle necrosis	12
Soil rot (pox, ground rot)	13
Phyllosticta leaf blight	14
Septoria leaf spot	15
White rust (leaf mold)	15
Yellow dwarf (feathery mottle)	16
Other virus diseases	17
Root knot	17
General control measures for field diseases	19
Seed disinfection	19
Hotbed sanitation	19
Vine or sprout (bed) cuttings	20
Storage rots and their control	20
Soft rot (ring rot, collar rot)	20
Black rot	22
Internal cork	23
Surface rot	24
Dry rot	25
Java black rot	26
Charcoal rot	27
Control measures for storage rots	27
Digging and handling sweetpotatoes	27
Management of the storage house	27
List of causal agents of sweetpotato diseases	28

Growth Through Agricultural Progress

Washington, D.C. Revised November 1959

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price 15 cents

Sweetpotato Diseases

By Earl M. Hildebrand, *pathologist, Vegetables and Ornamentals Research Branch, Agricultural Research Service,* and Harold T. Cook, *assistant chief, Biological Sciences Branch, Agricultural Marketing Service.*

The sweetpotato is one of the important food crops in the United States. It is grown in most southern States and more recently in many northern States. Field diseases and storage rots[1] probably reduce the marketable crop by as much as 10 percent. During the past decade virus diseases have become an increasing menace; they cause losses both in the field and in storage. Field diseases reduce yield, affect quality, cause roughness, poor color, and poor shape.

Black rot, a field and storage disease that gives sweetpotatoes a bitter taste when cooked, is a major cause of loss. Internal cork, not visible from the outside, is a virus disease that causes serious losses in stored roots.

Soft rots also reduce the supply of marketable sweetpotatoes and shorten the period this vegetable can be marketed. Disease in sweetpotatoes has a bad influence on their market.

Field Diseases and Their Control

Stem Rot

(Wilt, Blue Stem, Yellow Blight)

Description

In the field the first indication of stem rot is a slight change in the appearance of the youngest leaves. These become dull, then yellow between the veins, and pucker somewhat. Then the vines wilt and eventually the entire plant collapses and dies (fig. 1). The stems of diseased plants darken inside and sometimes split open at about the ground level. This discoloration of the stems sometimes extends 3 to 5 feet from the hill and this is a sure sign of stem rot. The fungus causing stem rot may also invade the fleshy roots and cause a blackened ring about a quarter of an inch below the surface (fig. 2). Sprouts from such sweetpotatoes are likely to be diseased.

In the plant bed the symptoms of stem rot are similar to those in the field. Diseased plants can generally be detected by the faint purplish tint that shows through the white part of the stem and by the yellow color of the leaves.

Distribution, Prevalence, and Loss

Stem rot probably occurs in every State where sweetpotatoes are grown. It is an important field disease and the most difficult to control.

[1] Scientific names of causal organisms (fungi and nematodes) are listed on p. 28.

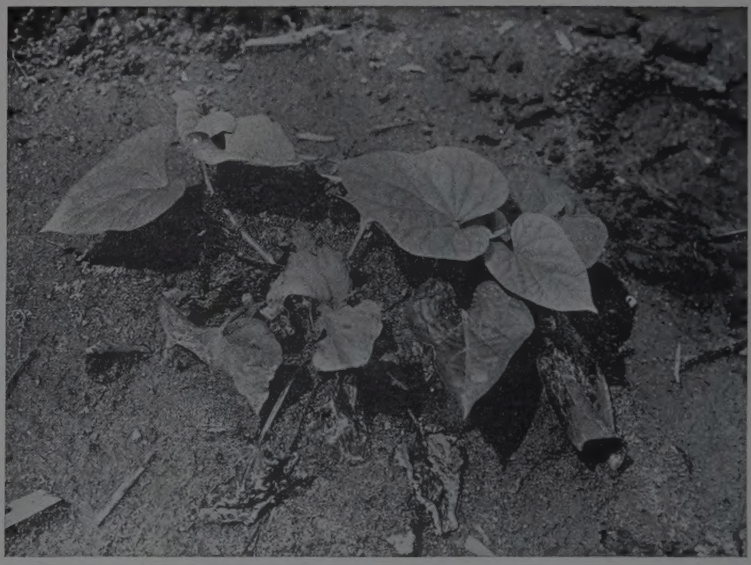


Figure 1.—Stem rot symptoms of a sweetpotato plant.

The disease is severe in New Jersey, Delaware, Iowa, in parts of Kansas, and in southern Illinois. From 10 to 50 percent of the crop may be destroyed in those States each year, and it has killed 95 percent of the plants in some fields. Although the losses in Maryland, Virginia, and Alabama are considerable each year, they are relatively less than in other States.

Figure 2.—A section through a sweetpotato, showing the blackened ring caused by the stem rot fungus.

Means of Distribution

The stem rot fungus can overwinter in the soil on the remains of dead sweetpotato vines and in the roots in storage. Therefore, the distribution of the disease from one field to another in the same locality may be brought about by (1) insects, (2) farm animals, (3) farm implements, (4) drainage water, (5) wind, and (6) discarded diseased roots dumped on the fields, either before or after being fed to stock.

The disease is spread from one locality to another primarily by the exchange or sale of seed sweetpotatoes and plants.

Cause

The fungus that causes stem rot can live for several years on decayed

vegetation in the soil until it again comes in contact with the sweetpotato.

Infection takes place both in the plant and in the field. The fungus in diseased seed stock planted in the plant bed grows into the plants. Such infected plants die soon after they are set in the field. Healthy plants may become infected after they are set in the field when the fungus in the soil grows into the roots.

The mycelium (threadlike web) of the fungus develops rapidly and grows up through the water-carrying vessels of the stem. After the vines die and turn black, the fungus lives on the decaying vegetation. Numerous fruiting bodies, or spores, develop on the dead vines. Being very small, the spores are readily carried by the wind, insects, and other agencies to other fields.

Control

Fertilizers and Fungicides.—Because the fungus causing stem rot invades the plant through its roots, fungicides applied on the plants or on the roots will not control the disease. Applications of lime and gypsum to the soil are of no control value.

Immune and Susceptible Varieties.—The following varieties, none of which are entirely immune, can be grown with comparative safety in infested soil: White Yam, Southern Green, Triumph, Red Brazil, Yellow Strasburg, Key West, and Dahomey. The following varieties are very susceptible to stem rot: Yellow Jersey, Big-Stem Jersey, Gold Skin, Nancy Hall, Porto Rico, Red Jersey, Georgia, Nancy Gold, Kansas 40, and Maryland Golden.

Seed Selection.—The stem rot fungus overwinters in sweetpotatoes in the storage house and grows from diseased stock into the plants developed from them. Slightly diseased plants are hard to detect, and, in consequence, many of them are set in the field, where the fungus continues to grow. It is, therefore, imperative that you use only healthy sweetpotatoes for the production of plants.

Healthy seed stock can be selected in the fall at digging time while the sweetpotatoes are still attached to the vines. Test each hill by splitting the stems, and select seed only from plants with stems that are not streaked inside with black. Do this before a killing frost, as a heavy frost will sometimes darken the stem. Fall selection of seed stock is necessary, for it is difficult in the spring or during the winter to tell whether the sweetpotatoes are diseased. After a period in storage a blackened ring a quarter of an inch below the surface often occurs even in healthy sweetpotatoes.

Store the sweetpotatoes selected for seed in a part of the house where they will not come in contact with the general stock.

Seed Disinfection and Bedding.—In the spring just before the roots are bedded, disinfect them by treating in a solution of corrosive sublimate (mercuric chloride) or of borax (p. 19). This treatment kills only the fungus spores that may be on the surface of the root and will not kill the fungus within the root.

Bed the sweetpotatoes immediately after the treatment in a properly prepared plant bed (p. 19).

Crop Rotation.—The stem rot fungus will live in the soil indefinitely, even in the absence of sweetpotatoes. For that reason, do not plant sweetpotatoes on the same ground oftener than once in 3 or 4 years. This rotation will not eradicate the fungus, but will reduce the losses. No other crop except tobacco is known to be attacked by this fungus; therefore, any crop except tobacco commonly grown in the region may be used in the rotation.

Black Rot

(Black Shank, Black Root)

Description

Black rot may occur on any of the underground parts of the plant. It produces dark to nearly black somewhat sunken, circular spots on the surface of sweetpotatoes (fig. 3).

Figure 3.—Black circular spot on sweetpotato caused by the black rot fungus.

When the plants are young, these spots are small and nearly round; under favorable conditions they enlarge and often involve nearly the whole sweetpotato. Fruiting bodies, or spores, of the fungus may often be found in circular areas about one-fourth to one-half inch in diameter in the center of the spots. The surface of the diseased spot has a somewhat metallic luster and the tissue just beneath is greenish. Infection on the plants begins as small black spots on the lower part of the stem and enlarges until the whole stem is rotted off. Frequently the infection extends up the stem to the surface of the soil (fig. 4). The name "black shank" is commonly applied to this phase of the disease. If sweetpotatoes affected with black rot are used for seed, the plants com-

Figure 4.—A small sweetpotato plant showing the characteristic blackening of the underground part of the stem caused by the black rot fungus.

ing from them will likely have the disease.

Sweetpotatoes affected by black rot have a very disagreeable taste when cooked, and their sale has a bad effect on the market.

Distribution, Prevalence, and Loss

Black rot is present in most of the States where sweetpotatoes are grown. The disease occurs on the plants or sprouts in the hotbeds, in the fields, and on the roots in storage houses in the winter. Heavy losses are caused by this disease in storage houses, where it develops freely under favorable conditions and renders the sweetpotatoes unfit for sale.

Means of Distribution

Black rot is spread in about the same way as stem rot. Unlike stem rot, however, black rot continues to develop in the storage house, and sweetpotatoes that appear sound when stored may become badly affected within a few weeks. Spread in the storage house may be brought about by rodents, by handling the roots when you are picking them over and preparing them for market, and by the roots settling in the bins. Washing the sweetpotatoes also may distribute the germs from one sweetpotato to another.

Cause

The black rot fungus overwinters on the dead vines and other decayed vegetable matter in the soil and on the sweetpotatoes in storage. No host plants other than sweetpotatoes are known. If roots affected by black rot are used as planting stock, the fungus usually grows into the plants while in the plant bed. Infection also takes place through the roots after the plants are set in the field. Plants that become infected early soon die, and those that continue to grow rarely produce any sweetpotatoes.

Control

None of the present commercial varieties are resistant to black rot.

Black rot is easily controlled by using disease-free seed sweetpotatoes, root disinfection, clean plant beds, and crop rotation.

The most practical way to obtain black-rot-free bedding stock is to grow seed sweetpotatoes from vine cuttings or sprout (bed) cuttings (p. 20). Since black rot affects only the below-ground parts of the plant, these cuttings will be free of the disease. They will produce disease-free sweetpotatoes that can be used for bedding the next year, if the cuttings are planted in fields that are free of black rot. Sorting out black-rot-infected sweetpotatoes, either at harvesttime or before bedding in the spring, is not a satisfactory way to obtain bedding stock. Many small, recent infections escape detection, and the disease continues to develop in storage or in the plant bed.

Disinfect the seed with either corrosive sublimate or borax to destroy black rot spores that may be on the surface. Disinfection does not kill the fungus inside of black-rot-infected sweetpotatoes (p. 19).

Bed the seed stock immediately after treatment in a properly prepared clean plant bed (p. 19).

Plant the sprouts on new ground or on soil that has not been used for sweetpotatoes for 3 or 4 years. Rotation of sweetpotatoes with other crops helps control black rot, because the fungus does not affect other crops and is only able to live about 2 or 3 years in the soil.

Treating the soil with sulfur, lime, gypsum, or various fertilizers has little effect on the disease. Dipping the plants in a solution of bordeaux mixture or in a lime-sulfur mixture just before they are set in the field may reduce the incidence of the disease, but does not prevent it entirely and has been found to injure the plants.

Foot Rot

(Die Off)

Description

Foot rot appears first as small brown to black spots on the stem of the plant near the soil line. The growth of the foot rot fungus is very slow at first, but eventually it girdles the plant and extends up the stem 4 or 5 inches. Soon the plant wilts, and rather numerous round, black specks, just visible to the naked eye, appear in the diseased areas (fig. 5). These specks are the fruiting bodies of the fungus. This disease progresses rather slowly, and the plants do not die off until about midsummer or later. In most instances the affected plants bear no sweetpotatoes, although long vines may have been produced.

In hills in which the sweetpotato

Figure 5.—The lower part of a sweetpotato plant killed by the foot rot fungus.

Figure 6.—A sweetpotato rotted by the foot rot fungus.

develops, the organism causing foot rot may spread from the infected stem to the roots and cause a brown and rather firm rot. Later, fruiting bodies develop close together on the surface in the form of pimplelike protuberances (fig. 6). Many wounds and bruises on sweetpotatoes in storage become infected with the foot rot fungus.

Distribution, Prevalence, and Loss

Foot rot is distributed in the same way as stem rot and black rot. It occurs in Virginia, Maryland, Ohio, South Carolina, Iowa, California, and Mississippi. Because it is not so widely distributed as black rot and stem rot, the total loss from foot rot is much less. In certain parts of Virginia, Ohio, and Iowa, it causes heavier losses than either black rot or stem rot.

Cause

Infection from the foot rot fungus takes place primarily through the roots or underground parts of the plant. However, during wet periods, when the growth is very luxuriant, diseased vines are sometimes found some distance from the hill. Infection takes place mostly in the hotbed by spreading from diseased seed stock to the plants. Such plants when set in the field usually die early in the season.

Spores, borne in great numbers, escape from the pimplelike projections of the diseased tissue and are carried by insects or other agencies to other plants, where new infections may result. If a diseased plant produces sweetpotatoes, the fungus often grows down the stem and infects them. The fungus may remain dormant during the storage period, but it will develop on the sprouts in the plant bed. As in the cases of stem and black rots, therefore, diseased seed stock produces diseased plants, which in turn may produce diseased sweetpotatoes in the field.

Control

For control of foot rot, follow recommendations for stem rot and black rot—seed selection, the use of clean plant beds, seed treatment, and crop rotation.

Scurf

(Soil Stain, Rust, Jersey Mark)

Description

Scurf produces a brown surface discoloration of the root (fig. 7). The discolored areas may take the form of spots of different sizes and shapes with no definite outline, or there may be a uniform rusting of the surface of the sweetpotato. Scurf is usually worse at the stem end. The skin of the sweetpotato is not broken, and the brown color is only skin deep and can be scraped off easily with the fingernail.

Distribution, Prevalence, and Loss

Scurf is commonly found almost everywhere that sweetpotatoes are grown and on nearly all varieties.

The losses to the crop caused by scurf are perhaps small in comparison with those caused by some of the other diseases. Nevertheless, scurfy sweetpotatoes do not command so high a market price as clean ones, although they are just as good for food.

Scurf, under favorable conditions of relatively high humidity and temperature, continues to develop under storage conditions to a limited degree. It may damage the sweetpotato skin, so that when the storage house is rather dry the root loses moisture and becomes shriveled and dried.

518863°—59——2

Figure 7.—A sweetpotato showing discoloration caused by the scurf fungus.

Cause

The scurf fungus overwinters in storage and on the decayed vines and other decayed vegetable matter in the field. If infected sweetpotatoes are used for seed, the fungus grows up on the stem of the plants and is carried on them to the field. Later, the organism in the field grows down onto the roots of the sweetpotatoes. Scurf is most severe on heavy soils and on those containing a large quantity of organic matter. It is likewise more severe during a wet season and on low, wet ground. Such soils should be avoided.

Control

You can control scurf easily by practicing crop rotation and using clean planting stock. Clean planting stock is most easily obtained by planting either vine cuttings or sprout (bed) cuttings in soil that has not been planted to sweetpotatoes for 3 or 4 years (p. 20). Since scurf affects only the underground parts, the cuttings will be free of the fungus. If you plant the cuttings in scurf-free soil, the sweetpotatoes produced will be free of that disease. Bed the scurf-free sweet potatoes produced from the cuttings the following year, and pull the sprouts in the usual manner. Selection of scurf-free seed by sorting is impractical and not very effective, because many of the scurf spots are too small to detect.

Plant the disease-free bedding stock in a clean plant bed. Otherwise, the sprouts from the disease-free sweetpotatoes may become infected with scurf from the bedding soil.

Seed treatment with a corrosive sublimate solution containing wettable sulfur partly reduces scurf (p. 19), but treatment with plain corrosive sublimate is not effective.

Root Rot

(Texas Root Rot)

Description

Root rot causes a firm brown rot, resulting in complete destruction of the sweetpotato (fig. 8). Aboveground, the growth is within the stem and may be detected by the brown color produced. The causal agent produces coarse brown or gray strands of the fungus on the surface of the roots that can be detected easily with a hand lens.

Distribution, Prevalence, and Loss

Root rot occurs in Texas, New Mexico, Oklahoma, Arizona, California, Arkansas, and Nevada. When the disease once gets into a field a crop may be destroyed. Large fields have been seen in which not more than 10 percent of a crop was produced. The growing crop appeared normal when viewed from a distance, but when harvested nearly all of the sweetpotatoes were found destroyed.

The causal organism lives from one season to the next in the soil on dead vegetable matter and probably on growing winter crops and weeds. It is killed by hard freezing, and this alone probably restricts the disease to the Southern States. The disease may be observed occasionally as early as May or June, but it does not become serious until August when the vines are usually well developed and the sweetpotatoes are of considerable size. From August on the disease increases in severity, and by harvesttime in September and October, a large percentage may be destroyed. The disease may occur in spots of various sizes within a field. Not all hills and not all sweetpotatoes in a hill are necessarily destroyed.

Cause

The root rot fungus lives from one season to the next in the soil and on seed sweetpotatoes. The organism gains access to the underground parts of sweetpotato plants and spreads in both directions, invading the vines from 6 to 12 inches above ground. It may enter the end of the sweetpotato or may cause spots of varying sizes on the surface.

Control

Root rot is more severe on black, poorly drained soil and during wet seasons. The disease is very difficult to control or eradicate, because it

Figure 8.—The characteristic shriveling produced by the root rot fungus.

occurs on a great variety of plants. It is particularly destructive on cotton and alfalfa. To control root rot, cultivate deep and clean, aerate the soil, apply stable manure, rotate crops, and use disease-free sweetpotatoes for seed. Use grasses, corn, and other cereals in the rotation, as they are partially or completely immune to the disease.

Mottle Necrosis

Description

Mottle necrosis, a field disease of sweetpotato, produces brownish, somewhat sunken spots, which are irregular in shape and size (fig. 9). Usually the sweetpotato remains more or less firm. Cutting the root crosswise through one of the brown, sunken surface spots reveals the most striking symptom of the disease: irregularly shaped patches of chocolate-brown dead tissue which appear to have no connection with one another and give the cross section a marbled appearance (fig. 10). The entire sweetpotato may be involved even though there is but a small spot of diseased tissue on the surface.

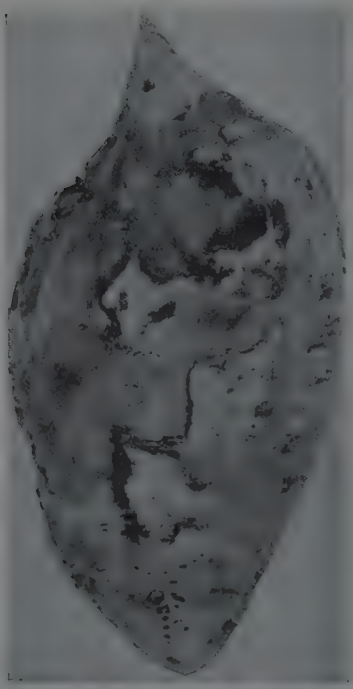


Figure 9.—A sweetpotato with a large part of the surface brown and somewhat sunken, a condition characteristic of the advanced stage of mottle necrosis.

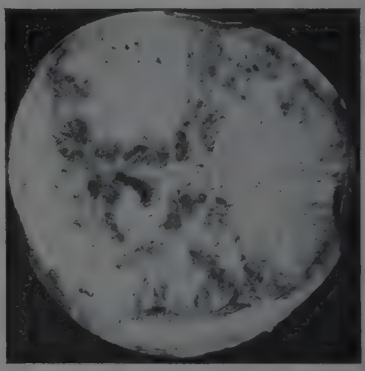


Figure 10.—A cross section through a sweetpotato, showing the characteristic mottling of mottle necrosis.

Distribution, Prevalence, and Loss

Mottle necrosis occurs in most States where sweetpotatoes are grown. It is not so prevalent, however, in the South as in the northern part of the sweetpotato-growing area. The loss varies from year to year, depending upon soil and weather conditions and on the varieties grown. The entire loss throughout the country is relatively small. However, in certain isolated districts where such varieties as the Yellow Jersey are grown, losses as high as 40 percent of the crop sometimes occur during seasons especially favorable to the disease.

Cause

Mottle necrosis may be caused by either of two fungi. These fungi probably enter through the small fibrous roots and spread through all parts of the sweetpotato.

Control

No method for the control of mottle necrosis has been worked out. The disease is most severe during seasons of abundant rainfall and in soils that are fairly light and sandy, although some infection may occur in fairly heavy soils. Very susceptible varieties are Triumph, Yellow Jersey, Big-Stem Jersey, and Georgia. Occasionally other varieties may be slightly infected. Do not plant susceptible varieties in soils where mottle necrosis has occurred in the preceding 3 or 4 years.

Soil Rot

(Pox, Ground Rot)

Description

Soil rot produces symptoms very different from those of other sweetpotato diseases. In a heavily infested soil the plants are dwarfed and often produce only one or two short vines. The leaves are small, thin, and pale green. The aboveground symptoms are the result of injury to the root caused by the disease. Any of the underground parts of the plant may be attacked. Many of the lateral feeding, or fibrous, roots are destroyed, and those that remain are often more or less malformed. Nearly black flecks, or spots, of varying sizes and appearance, occur on the feeding roots and underground part of the stem. The decayed spots may occur on only one side of the root or may girdle it, thereby cutting off the food supply. In the early stages of soil rot the diseased spots seem to be covered by the skin of the sweetpotato, which later breaks, leaving conspicuous holes or pits. On the swollen roots these pits often attain a diameter of one-half inch or more and have a jagged margin (fig. 11). The enlarged root is sometimes girdled; the sweetpotato continues to enlarge on each side of the point of infection and becomes dumbbell-shaped.

Figure 11.—A sweetpotato showing typical soil rot pits.

Distribution, Prevalence, and Loss

Soil rot occurs in California, more or less generally in the Southern States, and in practically all Northern States where sweetpotatoes are grown. It has become a limiting factor in sweetpotato production in Louisiana. The disease does not occur generally throughout a State, but it is more or less localized. It may be bad in one field or locality and absent in another only a few miles away.

The loss caused by soil rot may range from practically nothing to almost complete failure in different fields and seasons. Losses are most severe during dry seasons and on poor soils. Soil rot is especially severe on soils that are alkaline or only slightly acid. It does not develop much in fairly acid to acid soils; that is, with a soil reaction of pH 5.2 or less.

Cause

The soil rot fungus lives in the soil from one season to the next. Most of the infections probably occur after the plants are set in the field, although infection may result from infested soil in the hotbed and from infected seed sweetpotatoes.

Control

No adequate control measure is known for soil rot. Some research results indicate that application of sulfur to reduce the soil reaction to pH 5.2 or less will reduce the amount of soil rot and increase the yield. Apply sulfur with considerable care, as it may make the soil reaction unfavorable for succeeding crops. Apply the sulfur broadcast and incorporate it thoroughly into the soil 2 to 4 weeks before the plants are set out. The amount of sulfur you should use will depend on the soil type and pH. Use stable manure and green-manure crops to improve the soil and rotate crops.

Avoid introduction of the soil rot organism into new fields and new localities. Since cattle or other livestock can carry the germs on their feet, do not allow them to roam from infested to disease-free fields. Thoroughly clean plows and other farm implements used to cultivate infested fields before the equipment is taken into clean fields. If you purchase plants from outside sources, be sure they are free of soil rot. Obtain disease-free planting stock for use on new fields by means of vine or sprout cuttings (p. 20).

Phyllosticta Leaf Blight

Phyllosticta leaf blight causes roundish or angular brownish spots one-eighth to one-half inch in diameter on the upper side of the leaf (fig. 12). A number of black bodies about the size of a pin point and just visible to the naked eye are scattered within the spots. The bodies are slightly raised, round, and contain numerous colorless spores.

The fungus does not live on any other plant, nor does it occur on other parts of the sweetpotato plant. It probably lives through the winter on the dead leaves. The disease occurs every year in practically all the Southern States, but it is less common in New Jersey, Delaware, Maryland, Iowa, Kansas, and Illinois.

Phyllosticta leaf blight has never been serious enough to require remedial measures.

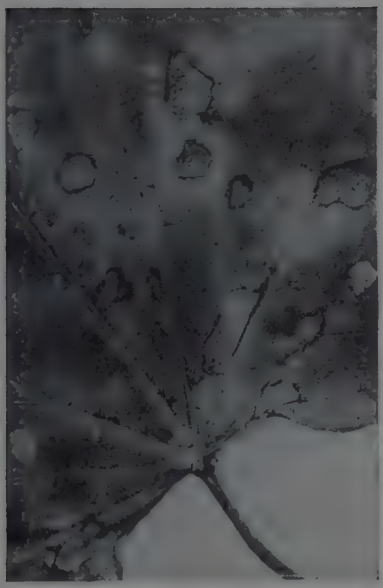


Figure 12.—Circular phyllosticta leaf blight lesions on a section of a sweetpotato leaf.

Figure 13.—A sweetpotato leaf showing white spots caused by the septoria leaf spot fungus.

Septoria Leaf Spot

Septoria leaf spot is characterized by circular, white spots about one-eighth inch in diameter on the upper surface of the leaves (fig. 13). Within these white areas are one or more black specks, just visible to the naked eye. These specks contain numerous spores that, upon escaping, may be carried by insects or other agencies to other leaves and start new infections. Like the organism causing leaf blight, this fungus does not live on other plants or on other parts of the sweetpotato than the leaves. It probably overwinters on the dead leaves in the field.

Septoria leaf spot is very widely distributed, having been collected in most States where sweetpotatoes are grown. This disease is not serious enough to require remedial measures.

White Rust

(Leaf Mold)

The first symptom of white rust is the loss of the green color in spots on the underside of the leaf (fig. 14). Later these spots become brown and covered with a whitish, viscid growth, which finally becomes more or less powdery. This powdery white mass is made up of

Figure 14.—Sweetpotato leaf injury caused by the white rust fungus.

numerous spores. These spores fall on other leaves and under favorable conditions will cause new infections. No great harm results from the attack of this fungus, though it may sometimes produce swellings on the stems and petioles (leaf stems) and cause malformations of the leaves and young shoots. White rust is widely distributed and occurs on a number of other plants, among them the wild morning-glories.

White rust is more prevalent during wet seasons. It is frequently found on sweetpotato plants in most of the Southern States. Under favorable weather conditions it occurs in New Jersey and other Northern States where sweetpotatoes are grown. This disease has never been serious enough to require remedial measures.

Yellow Dwarf

(Feathery Mottle)

Description

Feathery mottle was the first name applied to a disease which causes a systemic yellowing and dwarfing of sweetpotato plants. However, after a recent survey in States where the disease is known to occur, the name yellow dwarf, as used in California and New Jersey, seems more accurately to describe the overall leaf symptoms of the disease in those States and in Maryland and Georgia. In early stages of the disease on young plants the leaves commonly are mottled with green and yellow or there may be a feathery yellowing which gave the disease its earlier name. In some varieties, particularly Porto Rico, the leaves produced after infection may be distorted, and often fan-shaped. In later stages all varieties are dwarfed and the leaves yellowed. These plants produce few roots and those produced are dwarfed and misshapen. Many infected Porto Rico plants produce no fleshy roots and about 20 percent of the plants may die.

Distribution, Prevalence, and Loss

In the United States, yellow dwarf has not assumed major importance as a disease, probably because average weather and growing conditions generally do not favor the rapid multiplication of the whitefly which spreads the virus. The disease appears to be most prevalent in Georgia and California, although it occurs in other States. Where yellow dwarf occurs the dwarfing of the roots makes diseased plants practically worthless and a general infection of the field causes serious loss.

Cause

The yellow dwarf virus lives from one season to the next in the roots of diseased sweetpotatoes. Since it apparently is not seedborne, its survival in the true seeds of either wild morning glory or the

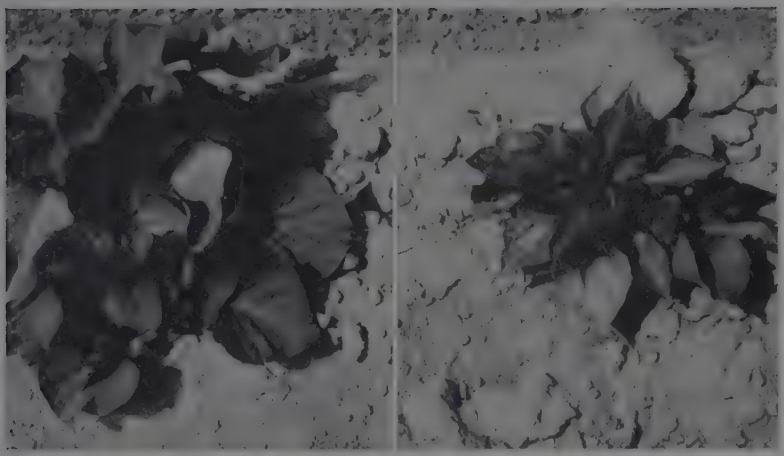


Figure 15.—Yellow dwarf virus symptoms on sweetpotato. Note the lighter color and smaller size of the foliage on the diseased plant at the right.

sweetpotato is improbable. The virus is transmitted by a species of whitefly.

Control

The yellow dwarf virus is carried in the roots of infected plants and such roots produce diseased sprouts when used for propagation. The completely diseased plants generally are so severely stunted that the roots are few and too small for use by growers who propagate plants from average-sized roots. However, current-season infections may not show either leaf or root symptoms. The best means of reducing losses, as with internal cork (p. 23), is to endeavor to obtain relatively virus-free planting stocks. The use of insecticides to prevent spread of the disease by whiteflies appears to be of some value in checking the spread of yellow dwarf.

Other Virus Diseases

A virus disease, commonly called ringspot, produces a spotting of the leaves. It is generally found associated with internal cork but so far it has not appeared to cause serious injury to the plant.

A strain of tobacco mosaic virus occasionally occurs in plants of Nancy Hall and a few other varieties but does not seem to be of economic importance.

Root Knot [2]

Description

Root knot is a nematode disease characterized by small galls or swellings on the fine feeder roots, stunting, and yellowish plants. The vines are seldom killed. On the sweetpotatoes this disease causes surface blemishes, pitting, and sometimes severe cracking. Inside the sweetpotato and roots, the nematodes may cause brownish spots about one-sixteenth inch or smaller in diameter. Most of the spots occur within one-fourth inch of the surface, but some spots may extend as much as 1 inch deep.

[2] Prepared by A. L. Taylor, nematologist, Agricultural Research Service.

Distribution, Prevalence, and Loss

Root knot occurs wherever sweetpotatoes are grown, but usually it is considered a minor disease of that crop. In some fields it may seriously reduce yield and quality.

The root-knot nematodes are able to live from one season to another in the soil and in sweetpotatoes in storage. They are spread by means of root-knot-infected seed sweetpotatoes and plants, by infected transplants of other kinds of plants, and by farm animals, farm implements, drainage water, and wind.

Cause

Root knot is caused by root-knot nematodes (sometimes called nemas and eelworms). The nematodes feed on the roots of hundreds of kinds of plants. While most common in the Southern States, root-knot nematodes may occur in any part of the country where sweetpotatoes are grown. Soil in which infected plants have been grown contains numerous nematode larvae, which are slender microscopic worms about one-fortieth inch long. These enter the roots and develop to become males, which are slender worms about one-twentieth inch long, or females, which are pear-shaped and about one-twentieth inch long by one-thirtieth inch wide. The males leave the roots, but the females remain embedded during their whole lives. Each female may produce several hundred eggs.

Control

For control of root knot in sweetpotatoes use plants that are free of nematodes and plant them in soil free of nematodes. Plants grown from infected seed sweetpotatoes or in plant-bed soil infested with root-knot nematodes will certainly become infected and carry the infection to the field soil. Slice samples from the lot of sweetpotatoes that are to be used for seed and examine for the brownish spots that indicate the presence of root-knot nematodes. If you find nematodes, the lot should be discarded.

If there is any possibility that the soil to be used for the plant bed has been infested with nematodes, it should be treated with a nematocide (or soil fumigant) before use. For this purpose, nematocides having as the active ingredient methyl bromide, chloropicrin, dichloropropene, ethylene dibromide, or sodium methyldithiocarbamate are satisfactory. These nematocides are sold under various trade names and should be used as recommended by the manufacturer.

In the field, root-knot nematodes can be controlled by crop rotation or by soil fumigation. Since suitable rotation crops vary in different parts of the country, it is advisable to consult your county agent or the State Agricultural experiment station before starting a nematode-controlling rotation. For field soil fumigation nematocides containing either dichloropropene or ethylene dibromide should be used as directed by the manufacturer.

(The above nematocides are those which can be recommended at the date of issue of this bulletin. It is probable that other nematocides suitable for use in sweetpotato production will be available in the future.)

Several sweetpotatoe varieties have been reported as being highly resistant to root-knot nematodes at various locations. However, it is now known that sweetpotatoes may be attacked by several different species of root-knot nematodes, and sweetpotato varieties that show resistance at one location may not be resistant at another location where a different species of nematode is present. Local experience is the best guide in selecting resistant varieties.

General Control Measures for Field Diseases

Seed Disinfection

Disinfect sweetpotato roots just before they are bedded by dipping them for 8 to 10 minutes in a solution made by dissolving 1 ounce of corrosive sublimate (mercuric chloride) in 8 gallons of water. Use only wooden vessels for the disinfecting solution.

To control scurf, add 5½ pounds of wettable sulfur to 24 gallons of the corrosive sublimate solution. This treatment will not kill fungi within the sweetpotato, but it will destroy spores on the surface. After about 10 bushels have been treated in 24 gallons of solution, add one-half ounce of corrosive sublimate dissolved in hot water and make up the solution to the original volume by adding water. Repeat this process after the treatment of each 10 bushels of seed until 30 bushels are treated. Then discard the solution and prepare a fresh one.

If corrosive sublimate cannot be obtained, disinfect the seed sweetpotatoes by immersing them for 5 minutes in a 2- to 2½-percent solution of borax. Prepare this solution by dissolving 5 pounds of borax in 30 gallons of water. Borax can usually be purchased at a grocery store. The disinfecting quality of the borax is not reduced by repeated use and it can be used in metal vessels. However, if the volume of the solution does not cover the sweetpotatoes, add more solution.

Bed the sweetpotatoes immediately after they are treated and water them thoroughly. Otherwise chemical injury and reduced sprouting may result.

Excessive amounts of boron are injurious to plants; therefore, do not pour the unused portion of the borax solution on land to be used for crop production. Corrosive sublimate is very poisonous. Sweetpotatoes that have been treated with either corrosive sublimate or borax should never be fed to animals or used as food. The chemicals and the solutions remaining after treating should be carefully disposed of or kept out of reach of children and animals.

Hotbed Sanitation

The repeated use of the same soil year after year in the plant bed is probably one of the chief means of distributing many sweetpotato diseases. Disease-producing organisms multiply in the rotting roots and manure. If the same soil is used the next year, the sweetpotatoes are at once exposed to infection. Furthermore, when bedding sweetpotatoes, farmers frequently throw the diseased ones to one side. These eventually become mixed with the soil, and the disease germs may be carried on the shoes and by chickens and other agents to the plant bed. As a result, plant beds that might otherwise produce healthy plants become badly infected.

Haul away all soil that has been used once in the plant bed and all the rubbish around the bed. Soak thoroughly the framework of the plant bed and the ground around it with a solution of 1 pint of commercial formalin in 30 gallons of water or with a solution of 1 pound of copper sulfate in 25 gallons of water. Repeat this treatment after about 24 hours. Obtain the soil, or preferably sand, for the hotbed from a place where sweetpotatoes have never been grown. Rich soil

is not necessary for the hotbed; in fact, some of the best results have been obtained by using pure sand. Use a grade of sand or soil that will not bake or form a crust. Clean the farm implements that were used to handle and haul away old soil and disinfect the implements with a solution of formaldehyde before new soil is handled.

The use of stable manure in the hotbed is a questionable practice unless you have taken care not to feed discarded sweetpotatoes to stock or throw them on the manure pile. Do not throw diseased sweetpotatoes in the yard where infected parts may be carried around on the feet of poultry, other farm animals, and workers.

Vine or Sprout (Bed) Cuttings

You may produce disease-free seed stock easily by planting vine cuttings or sprout (bed) cuttings in soil that has not been planted to sweetpotatoes for 3 or 4 years. Since such diseases as black rot and scurf do not occur on the above-ground parts, they are not carried on the vine or bed cuttings as they are on sprouts that are pulled in the usual way.

Make vine cuttings by cutting the sweetpotato vines into sections so as to include at least two buds or leaves. Then insert one end, usually the larger, into the ground. A disadvantage with vine cuttings is that the cuttings cannot be made until the vines have grown to a considerable length.

You can obtain sprout or bed cuttings almost as early as sprouts. The sprouts are allowed to grow a few inches longer than usual and then cut about 1½ inches above the soil level instead of pulling them in the usual manner.

To obtain good results from vine or sprout cuttings, take the following precautions:

1. Make cuttings from vines that are not affected with stem rot. The stem rot organism grows out into the vines 3 to 5 feet from the hills and its presence cannot always be detected without pinching open the vine.

2. Plant cuttings on new ground or on ground on which sweetpotatoes have not been grown for at least 3 or 4 years.

3. Disinfect the seed stock and bed it in a plant bed prepared according to directions given on page 19.

Storage Rots and Their Control

Soft Rot

(Ring Rot, Collar Rot)

Soft rot, caused by the bread mold, is a very destructive disease of sweetpotatoes in storage. It may set in soon after the crop is placed in storage and continue to spread throughout the storage period, depending largely on the condition of the roots when stored and on the management of the house. The decay begins usually at one end and progresses rapidly, requiring only a few days with favorable temperatures and humidity to destroy the entire sweetpotato. At first the soft-rot-affected sweetpotatoes are soft, watery, and stringy. After decay and the escape of moisture, they gradually become firm, hard, shrunken, and brittle. Such dry sweetpotatoes are frequently referred to by the farmer as being affected with dry rot, which in reality

is a dried-up soft rot. If the skin is broken while the sweetpotato is still soft, a moldy growth, sometimes referred to as whiskers, forms on the surface (fig. 16).

The soft rot disease often spreads from one root to another by contact. The spores of the black mold produced on the surface may be carried by flies or wind currents to other roots in the same house or may be spread to them by handling. New infections may take place if the spores light on a wounded surface and if the temperature and moisture conditions are favorable.

Ring rot differs from soft rot in that the decay begins at a point between the two ends of the sweetpotato instead of at one end. From the point of infection the decay forms a ring, or collar, around the sweetpotato, and then extends slowly toward the ends. Under conditions favorable to the mold the sweetpotato may be wholly destroyed. If conditions unfavorable for its further development exist, such as a relatively low humidity and low temperatures, it may only form a depressed ring, or collar (fig. 17), varying in width from 1 inch to 3 inches.

Figure 16.—A sweetpotato showing the moldy growth, or whiskers, of the fungus causing soft rot.

Figure 17.—A sweetpotato infected with ring rot.

The losses sustained in storage from soft and ring rots amount to many hundreds of thousands of dollars annually. The causal organism is found everywhere and will grow on almost any decaying vegetable matter. It is therefore impossible to exclude it from storage houses. The fungus generally gains entrance to the sweetpotato through wounds and bruises caused by rough handling or through wounds made by rats and mice.

Black Rot

Black rot is very serious in storage as well as in the field. The loss caused by it in storage and in the field probably equals that of all the other sweetpotato diseases combined.

When sweetpotatoes are dug, black rot spots are comparatively rare. Sometimes many potatoes may be infected, but the point of infection is so small that it is invisible to the naked eye. In the storage house, where the temperature and humidity are relatively high, these spots gradually enlarge. At the end of a month or two they have formed conspicuous, somewhat round, black sunken spots on the root (fig. 3). Near the center of these spots are innumerable minute, flask-shaped fruiting bodies from which myriads of small spores escape. Although black rot generally extends only a short distance into the flesh, it may penetrate as much as half an inch after several weeks' storage (fig. 18). Cutting a sweetpotato crosswise through a black rot spot will show that the flesh is black. A bluish-black color will soon develop in the tissues beneath the spot, sometimes almost to the center of the sweetpotato.

The spores of the fungus readily adhere to the bodies of insects and may be carried to other sweetpotatoes, where new infections may take place at wounds if sufficient moisture is present. The spores may also be scattered by workmen preparing potatoes for the market and by air currents inside the storage house.

Sweetpotatoes that contain even a small amount of black rot should not be washed because of the danger of spreading the spores. Nearly 100 percent of the sweetpotatoes in some commercial lots have become infected following washing. Even when the washed sweetpotatoes do not show black rot when shipped, they may be badly rotted before they reach market or before the consumer has time to use them.

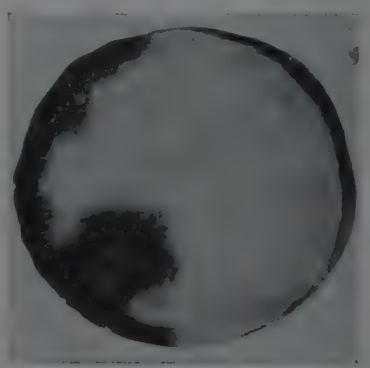


Figure 18.—Cross section through a sweetpotato with black rot lesion, showing depth of penetration by the black rot fungus.

Internal Cork

Description

Internal cork is a virus disease that causes dark brown to black, hard, corky spots in the flesh of susceptible sweetpotatoes (fig. 19). These spots vary in size and shape and occur singly or in groups. They are most readily detected by cutting the potatoes lengthwise or crosswise in thin slices. When the virus is present, small spots may be found in some roots at harvest, but usually spots are not present at digging time. Roots stored at the recommended temperatures of 55° to 60° F. show little further spotting but spotting increases rapidly at 70° F. and severely diseased roots may develop so many spots that they are practically worthless for food. Plants affected by the virus show yellow spots on the leaves that become masked as the leaves grow older.

Distribution, Prevalence, and Loss

Internal cork was first reported in South Carolina in 1944 and has since been recognized as being practically worldwide in distribution. A national survey in 1955–56 showed that the internal cork virus was present in every State and in all varieties examined. Porto Rico, Goldrush, and Red Velvet were generally susceptible but certain varieties such as Allgold, Redgold, Yellow Jersey, and Jersey Orange are less susceptible. Losses are hard to estimate because much of the crop may be marketed soon after harvest. After several months' storage roots of susceptible varieties stored at temperatures above 65° F. frequently are unmarketable.

Cause

The causal virus lives from one season to the next in the fleshy roots. It is not carried in the true seed of the sweetpotato or that of known susceptible host plants. Thus, there is no known overwintering of the virus in annual host plants such as wild morning glories. The cork virus is commonly spread in the field by aphids during their normal feeding activities and especially during the cooler weather in the spring.

Control

Internal cork is not easily controlled since infected roots show no external symptoms and produce infected sprouts when used for propagation. At present, the only feasible means of reducing internal cork in the growing crop is to obtain planting stocks from seed stock producers who are attempting to develop relatively virus-free stocks. Use of insecticides to prevent spread of the virus by insect carriers has not, as yet, been a successful means of control. Increase in number and size of cork spots in sweetpotatoes during storage may be retarded by keeping the storage temperature as near 55° F. as possible.

Figure 19.—Lengthwise sections of a sweetpotato, showing internal cork spots in the flesh.

Surface Rot

In the early stages surface rot is characterized by nearly circular spots (fig. 20) on the surface of the sweetpotato. These vary in number and size. The rot is shallow, seldom extending more than one-fourth to one-half inch below the surface. The sweetpotato shrinks later, especially at the margin of the spot. Finally it becomes dry and mummified.

Infection occurs at the base of the

small rootlets at about digging time, especially if the ground is wet, or early in the storage period. The infected areas gradually enlarge in storage and become conspicuous in 6 to 8 weeks. If the storage house is kept rather warm and dry, moisture escapes from the affected areas and the sweetpotato gradually becomes dry and hard.

Surface rot has some characteristics in common with black rot. Surface rot spots may become an inch in diameter and grayish brown during storage. Black rot spots are nearly black and may reach a diameter of more than 2 inches. The surface rot spots are more regular in shape and size than those caused by bruises.

The loss from surface rot is sometimes more than that of any other storage disease. Occasionally the sweetpotatoes are so badly shrunken that they have no market value. Some varieties shrink more than others. Some strains of the Jersey types, especially some of those with dark-yellow skin, are only slightly subject to surface rot. Light-skinned Jersey types, on the other hand, are more susceptible. There are no immune varieties.

Figure 20.—A sweetpotato after several weeks in storage, showing a number of circular lesions associated with surface rot.

Dry Rot

Dry rot generally begins at the end of the sweetpotato and produces a firm brown decay. The sweetpotato decays slowly and finally becomes dry, hard, and mummified (fig. 21). Small domelike, or pimplelike, protuberances just visible to the naked eye finally cover the entire surface and contain large numbers of colorless spores of the fungus. The tissue just beneath the skin is coal black. Several weeks are required under normal conditions for the fungus to destroy a sweetpotato completely.

The dry rot fungus grows on the stems and vines aboveground under field conditions, and probably some sweetpotatoes become infected in the field. Dry rot has also been found on the stems of young plants in hotbeds.

Dry rot, which is widely distributed throughout the country, is not regarded as one of the more serious storage disorders.

Figure 21.—The characteristic appearance of dry rot.

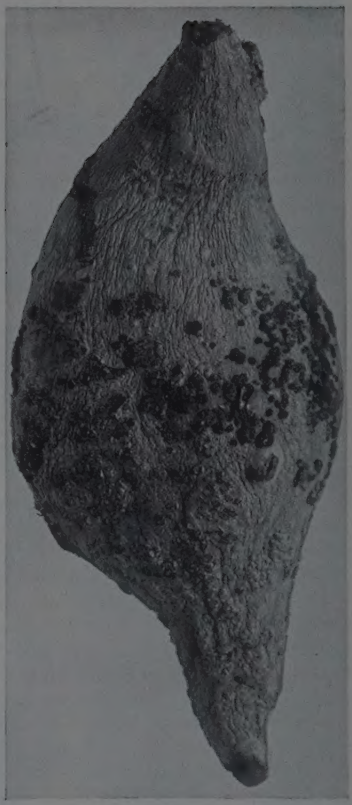


Figure 22.—A sweetpotato showing the dry, mummified condition produced by the Java black rot fungus.

Java Black Rot

Java black rot, so called because it was discovered on sweetpotatoes grown from an importation from Java, is a widely distributed storage disease. It is more prevalent in the South than elsewhere.

Java black rot is strictly a storage disease. The affected sweetpotatoes rot slowly and become dry, hard, brittle, and coal black within, and difficult to break (fig. 22). The disease is spread by spores that develop beneath the surface of numerous pimplelike protuberances. When the surface of the root is broken, these spore bodies are set free. Java black rot begins usually at the end of the root and progresses very slowly. Under normal storage conditions it takes the disease from 4 to 8 weeks to destroy a sweetpotato completely.

Charcoal Rot

Charcoal rot is found in storage houses throughout the country, but is more prevalent in the South. The characteristic black decay of the roots differs from others of a similar appearance by the production of minute spherical resting bodies throughout the interior of the sweetpotato, but rarely on the surface. These bodies are coal black and are found buried in the tissue when the skin is removed. They are visible to the naked eye. Some shrinking and drying of the sweetpotato follow invasion by the fungus, and the fleshy root may become a hard, dry, charcoallike mummy. The loss from this disease is comparatively small.

Control Measures for Storage Rots

The first step toward preventing storage rots is to control the field diseases as completely as possible, so that the sweetpotatoes will be free of diseases when they are stored. Some field diseases, such as black rot, continue to develop after digging and cause serious losses in storage. Other field diseases afford avenues of entry for secondary decay-producing fungi.

Digging and Handling Sweetpotatoes

Dig and handle sweetpotatoes as carefully as possible to avoid cutting and bruising, since most decay-producing organisms can enter only at wounds.

Haul the roots to the storage house and cure them at about 85° F. and 90 percent relative humidity as soon as possible after they are dug. Curing should continue for 6 to 8 days. If you cure the roots at this temperature and humidity shortly after they are dug, the wounds will heal before infection can take place.

After curing keep the storage temperature at or as near to 55° F. as possible and the humidity between 80 and 85 percent. Higher storage temperatures are more favorable to development of internal cork and sprouting. However, hold seed stock the first 6 weeks of the storage period at 70°, so that lots affected with internal cork can be more easily detected and discarded. Temperatures lower than 55° for more than short periods cause chilling injury and favor decay by fungi that attack only weakened sweetpotatoes.

Do not disturb sweetpotatoes after they have been cured, because they are easily injured and bruises and cuts allow entrance for decay organisms.

Management of the Storage House

Before the sweetpotatoes are put into storage, sweep out all the dirt and rubbish of the previous year. Thoroughly clean the walls and floor of the storage house or cellar and treat them with a fungicide. Probably the most effective method of treatment is to fumigate the house with formaldehyde gas.

Formaldehyde, which is an irritating and poisonous substance, must not be breathed or allowed to get into the eyes. It is thus necessary to get out of the house quickly after the gas is released.

Each 1,000 cubic feet of space to be fumigated requires 3 pints of commercial formalin (a 40-percent

solution of formaldehyde in water) and 23 ounces of potassium permanganate. As potassium permanganate loses its strength when exposed to the air, it should be kept tightly covered when stored. The required amount of formaldehyde should be placed in deep containers such as lard cans, garbage cans, open-end oil drums, or large crocks. The container should be of 5-gallon capacity or larger to keep the material from running over. The formaldehyde should not fill the container over one-tenth full, as it will boil up to several times its original volume upon addition of the permanganate.

For a large house several containers should be used. The required amount of permanganate for each jar is measured beforehand. All doors, windows, and ventilators should be tightly closed except one convenient exit door. Speed in handling is essential for safety.

Beginning with the container farthest from the door, pour the permanganate crystals quickly into the formaldehyde and proceed rapidly to the next container. After finishing with the container nearest the door, leave the house quickly and close the door. Because the gas generated is very irritating to the eyes, use goggles and gloves. Keep the house closed at least 24 hours; then open and ventilate thoroughly for at least 2 weeks.

In place of the 23 ounces of potassium permanganate, 36 ounces of fresh bleaching powder (chlorinated lime) can be used. Bleaching powder is commonly retailed in 12-ounce cans; the contents of one of these cans can be used for each pint of formaldehyde.

If bleaching powder is used, care should be taken not to inhale the chlorine fumes given off as they are poisonous and very irritating.

Crates, baskets, or grading tables that are to be used again for sweetpotatoes can be fumigated by keeping them in the house during the fumigation.

Remember, *don't* fumigate the storage house with sweetpotatoes in it.

List of Causal Agents of Sweetpotato Diseases

	Causal organism
Field diseases:	
Stem rot	*Fusarium oxysporum* f. *batatas*
Black rot	*Ceratocystis fimbriata* (formerly *Endoconidiophora fimbriata*)
Foot rot	*Plenodomus destruens*
Scurf	*Monilochaetes infuscans*
Root rot	*Phymatotrichum omnivorum*
Mottle necrosis	*Pythium ultimum* *P. scleroteichum*
Soil rot	*Steptomyces ipomoea*
Phyllosticta leaf blight	*Phyllosticta batatas*
Septoria leaf spot	*Septoria bataticola*
White rust	*Albugo ipomoeae-panduratae*
Yellow dwarf	*Virus*
Root knot	*Meloidogyne* spp. (formerly *Heterodera marioni*)
Storage rots:	
Soft rot	*Rhizopus stolonifer*
Black rot	*Ceratocystis fimbriata* (formerly *Endoconidiophora fimbriata*)
Internal cork	Virus
Surface rot	*Fusarium oxysporum*
Dry rot	*Diaporthe batatatis*
Java black rot	*Diplodia theobromae* (*D. tubericola*)
Charcoal rot	*Macrophomina phaseoli*

U.S. GOVERNMENT PRINTING OFFICE: 1956